

LA-UR-20-23810

Approved for public release; distribution is unlimited.

Title: Probabilistic Topography Project Update 5/20

Author(s): Jonko, Alexandra

Intended for: Briefing to GRA academic advisor on GRA's research

Issued: 2020-05-22

Disclaimer:

Los Alamos National Laboratory, an affirmative action/equal opportunity employer, is operated by Triad National Security, LLC for the National Nuclear Security Administration of U.S. Department of Energy under contract 89233218CNA000001. By approving this article, the publisher recognizes that the U.S. Government retains nonexclusive, royalty-free license to publish or reproduce the published form of this contribution, or to allow others to do so, for U.S. Government purposes. Los Alamos National Laboratory requests that the publisher identify this article as work performed under the auspices of the U.S. Department of Energy. Los Alamos National Laboratory strongly supports academic freedom and a researcher's right to publish; as an institution, however, the Laboratory does not endorse the viewpoint of a publication or guarantee its technical correctness.

Update 5/20

Probabilistic Topography Project

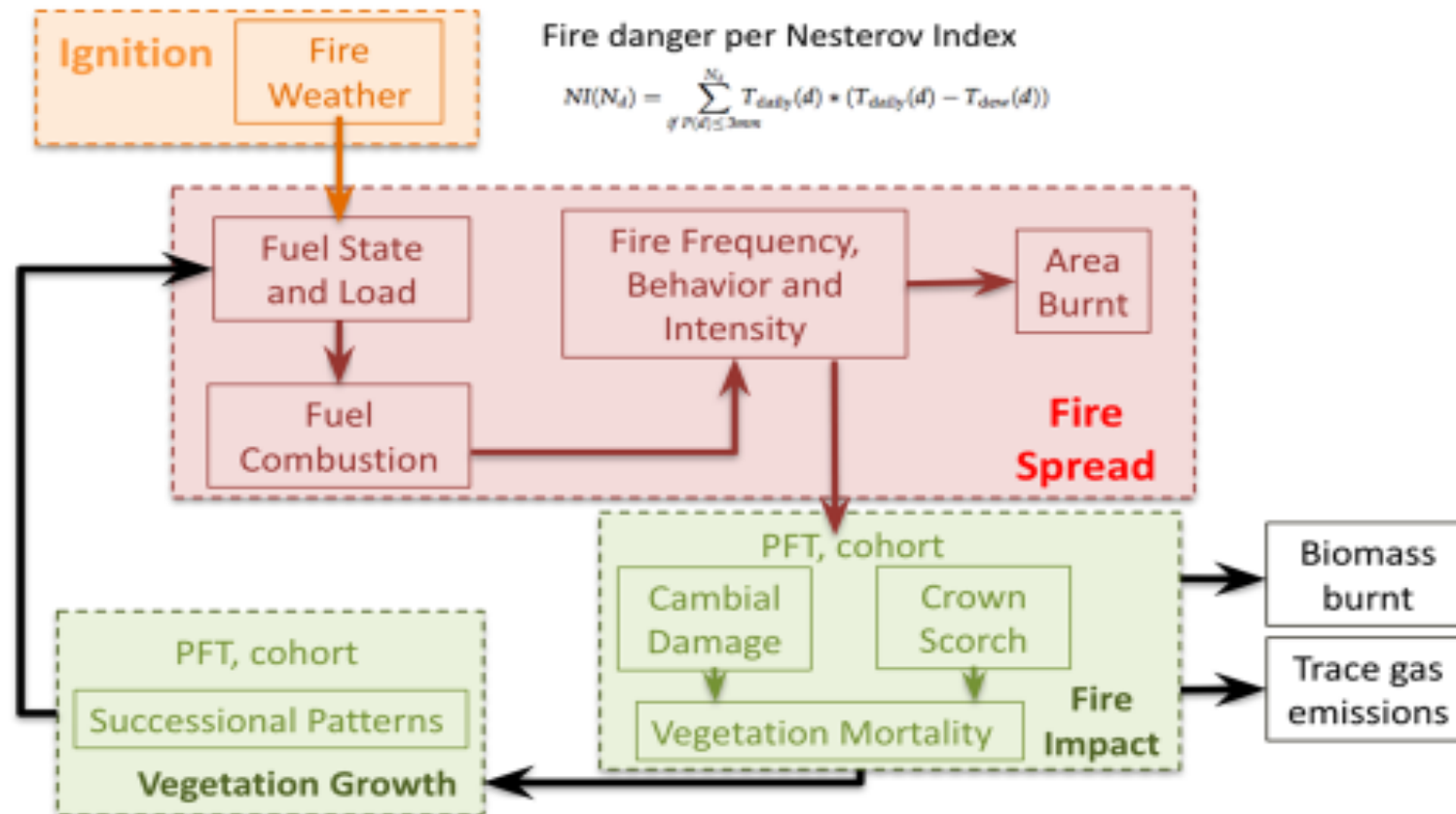
Problem/Goal :

- Earth System Models (ESMs) do not accurately predict fire spread
 - No effects from topography/vegetation heterogeneity below the model's scale (100-200km)
- Use physics based models (FIRETEC and QUICFIRE) to produce an archive of correction factors for SPITFIRE (chosen ESM)

SLIDE FROM PROJECT LDRD APPRAISAL

How do ESMs currently represent fire?

SPITFIRE is the most advanced fire module currently used in ESMs.

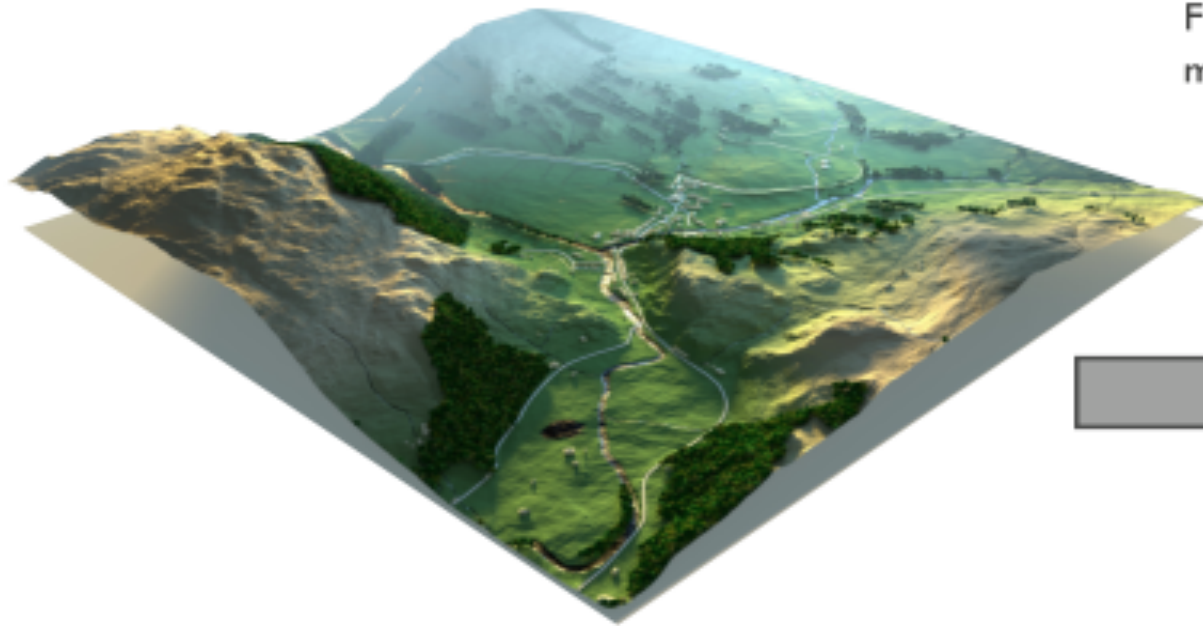


Adapted from Thonicke et al. 2010 Biogeosciences

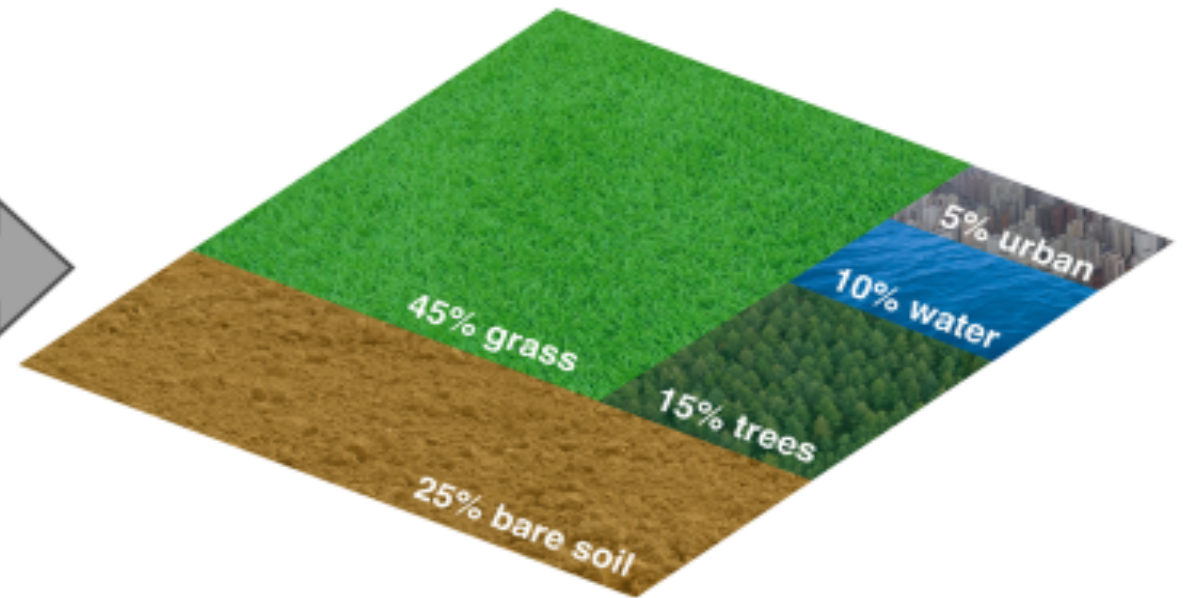
54

SLIDE FROM PROJECT LDRD APPRAISAL

How do ESMs currently represent fire?



Fire spread rates estimated based on land cover type and mean winds using empirical formulation (Rothermel, 1982)

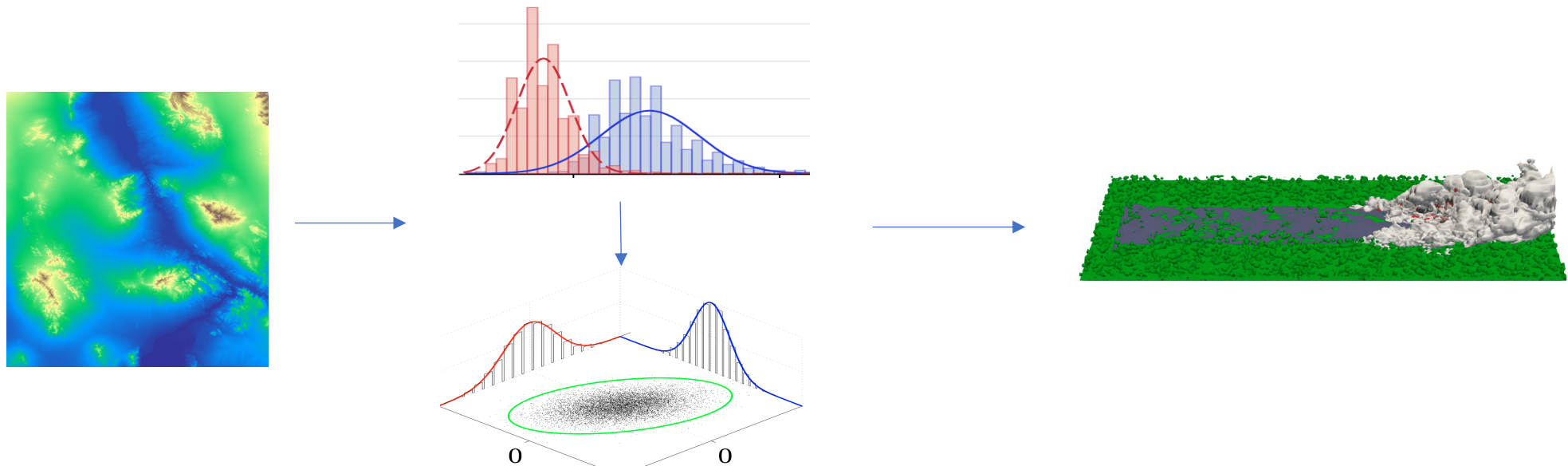


Not included in SPITFIRE:

- Topography → fires burn on a flat surface
- Landscape fragmentation → surface cover types are represented as % of an an grid cell

Project Overview

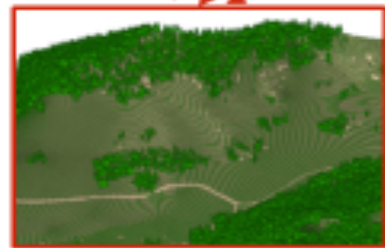
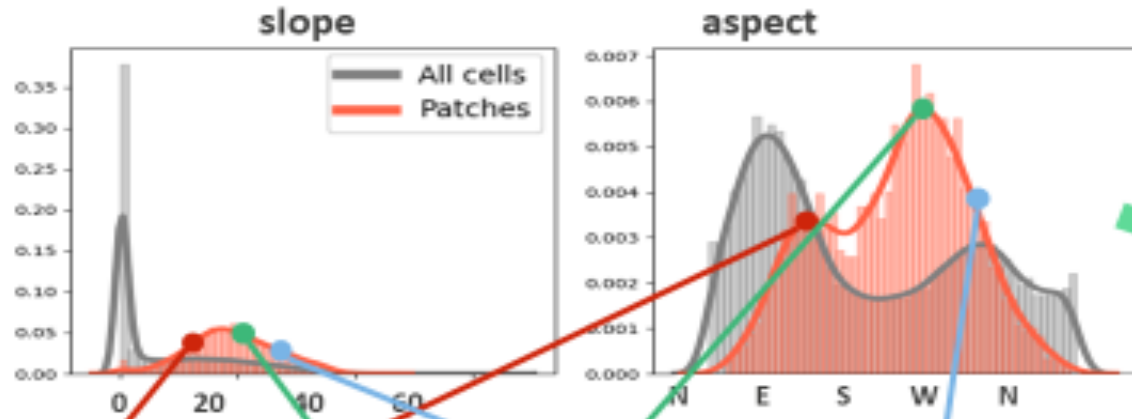
- Use datasets to create PDFs of slope & aspect, vegetation distribution
- Create joint distribution and sample to make new domain
- Run FIRETEC & QUICFIRE on created domain, record output (area burned, intensity, etc)
- Use output to create PDF of correction factors for SPITFIRE runs



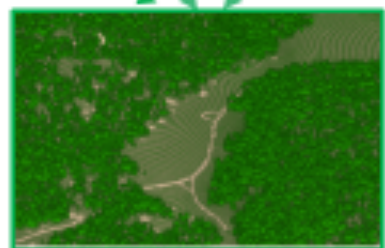
SLIDE FROM PROJECT LDRD APPRAISAL

Sampling and fuel bed generation

- fuel patch size
- distance between fuel patches
- topographic curvature
- info about predominant ridge lines
- ESM winds



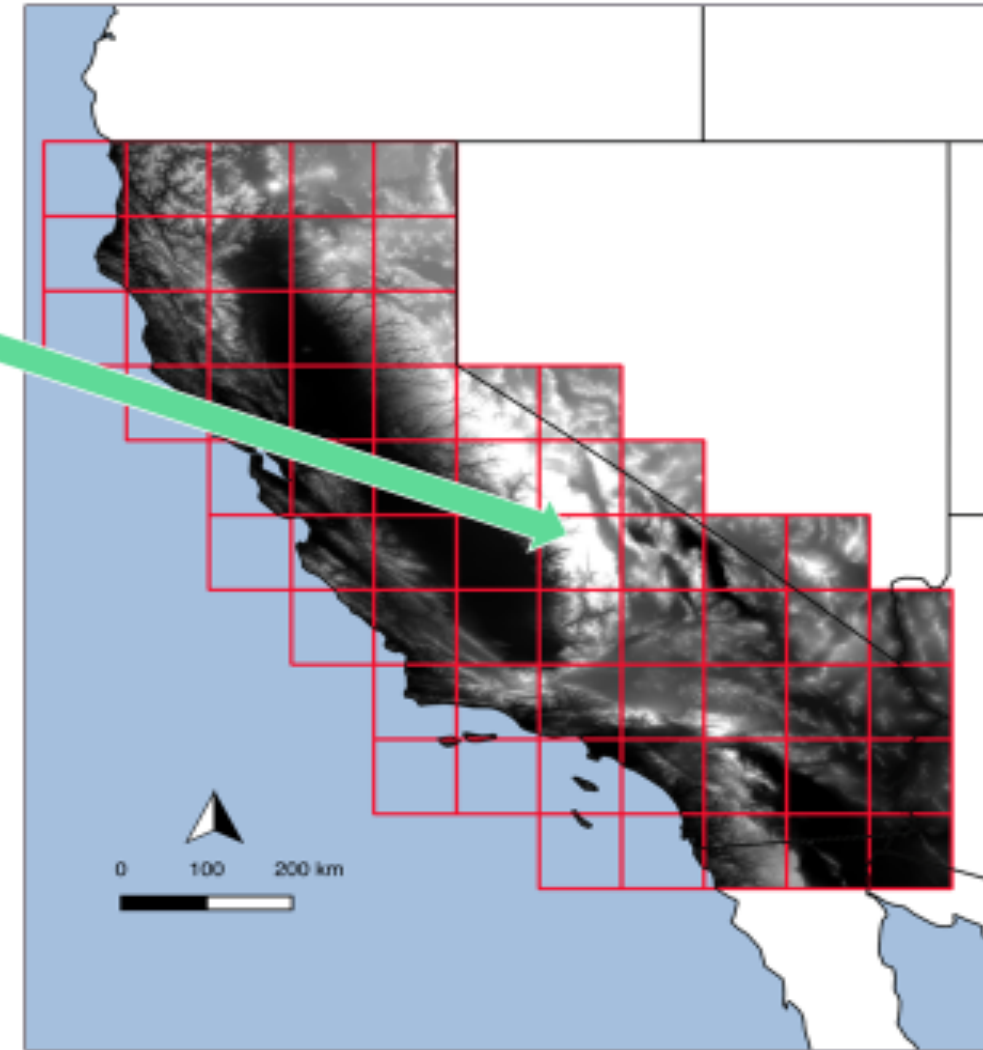
FIRETEC domain 1



FIRETEC domain 2



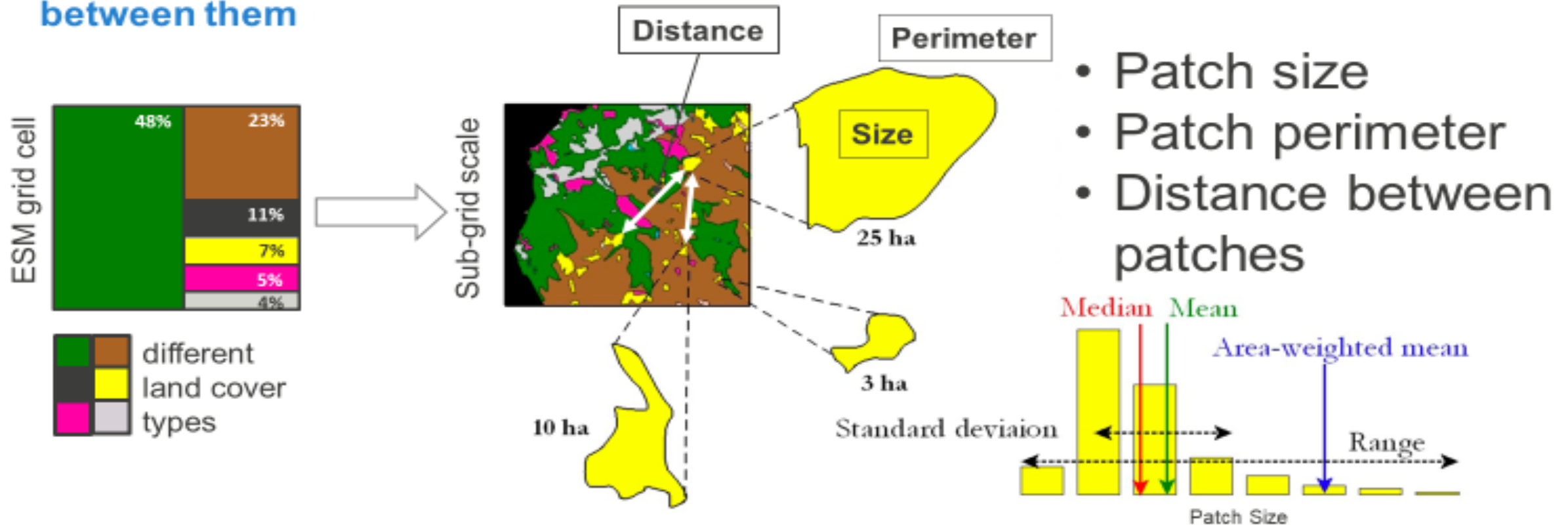
FIRETEC domain 3



SLIDE FROM PROJECT LDRD APPRAISAL

Estimating Burnable Patches

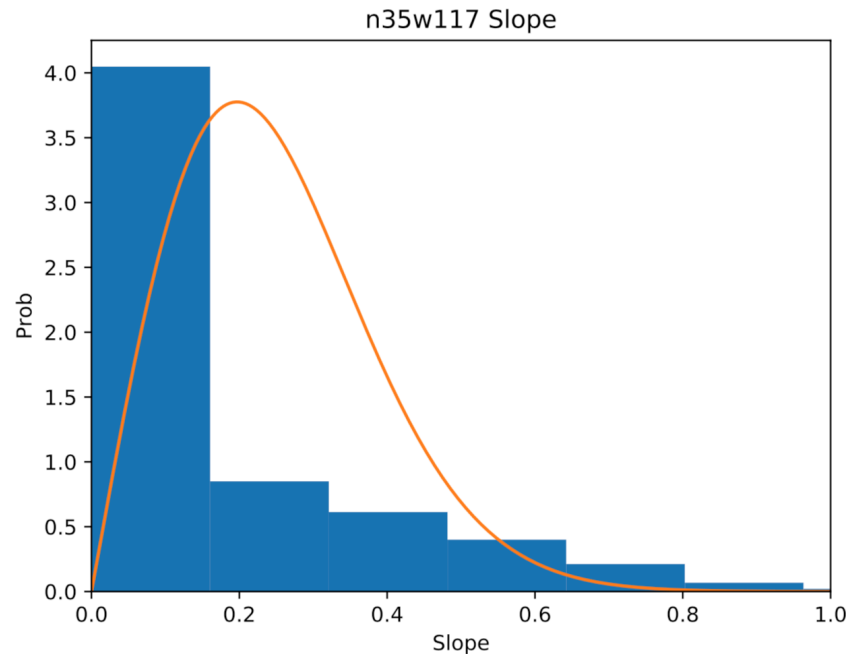
- Generate statistics from burnable patches to calculate size and perimeter of the burnable patches and the distances between them
- For each grid tile, calculate size of each patch, and then calculated distances between them



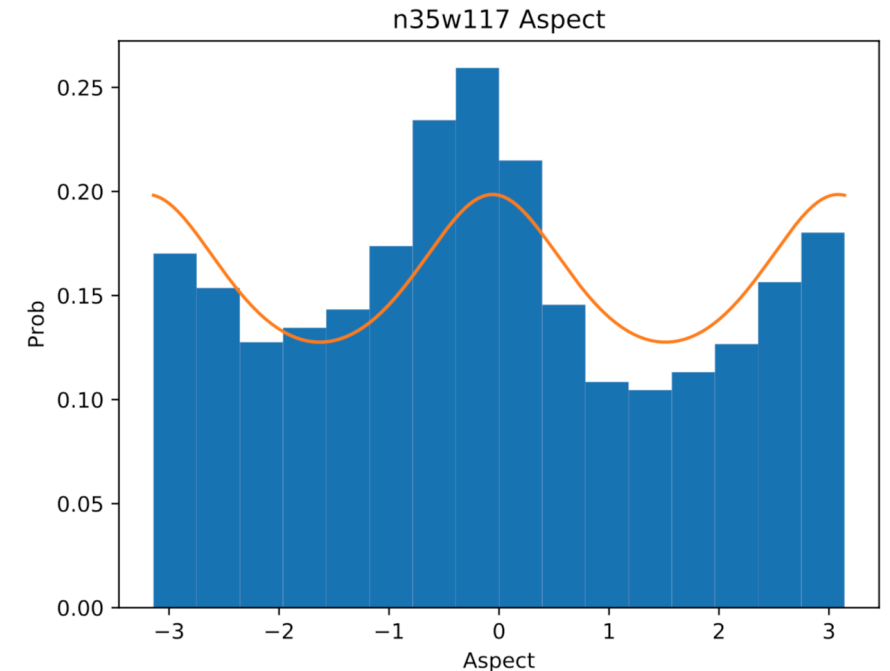
Current Work: Topography

Slope & Aspect

- Distributions created for California
- Using analytical distributions described in Vico&Porporato (2009) for slope and Bartlett (2013) for aspect



$$p_G(S) = \frac{S}{\sigma_{\partial_x h} \sigma_{\partial_y h}} I_0 \left(S^2 \frac{|\sigma_{\partial_x h}^2 - \sigma_{\partial_y h}^2|}{4\sigma_{\partial_x h}^2 \sigma_{\partial_y h}^2} \right) \exp \left(-S^2 \frac{\sigma_{\partial_x h}^2 + \sigma_{\partial_y h}^2}{4\sigma_{\partial_x h}^2 \sigma_{\partial_y h}^2} \right), \quad (13)$$

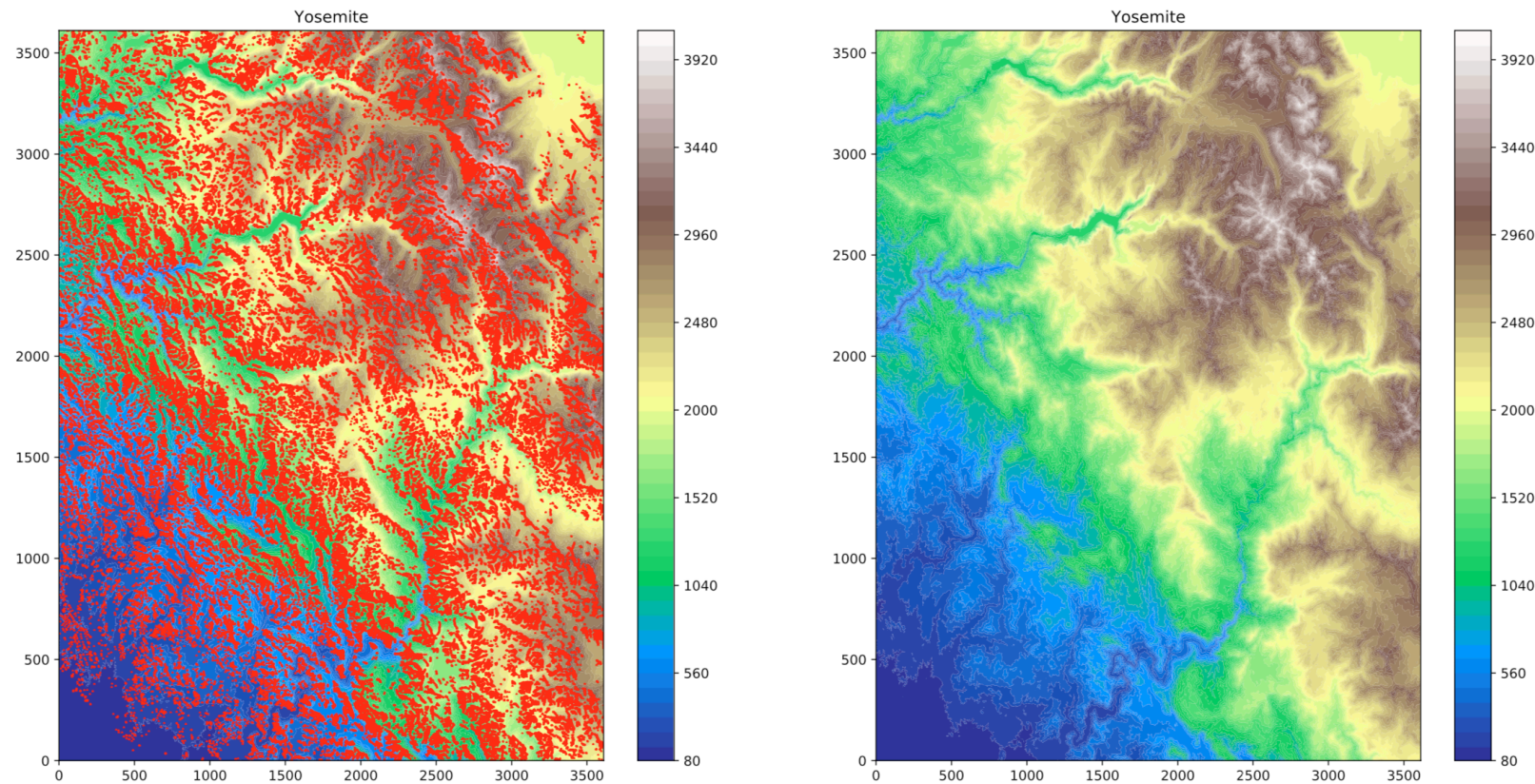


$$p(\alpha) = \frac{\frac{\sigma_y}{\sigma_x} \sqrt{1 - \rho^2} \sec^2[\alpha]}{2\pi \left[\frac{\sigma_y^2}{\sigma_x^2} (1 - \rho^2) + (\tan[\alpha] - \frac{\sigma_y}{\sigma_x} \rho)^2 \right]}, \quad -\pi < \alpha \leq \pi.$$

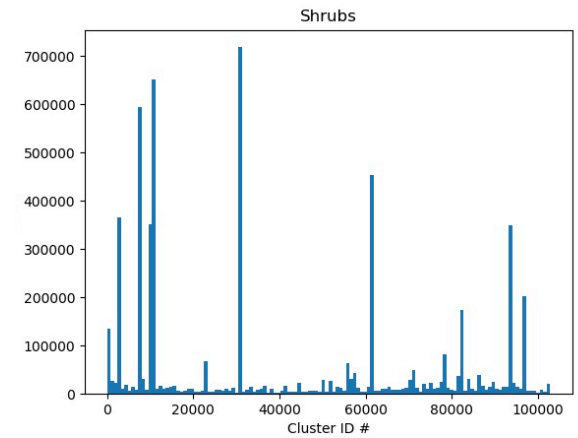
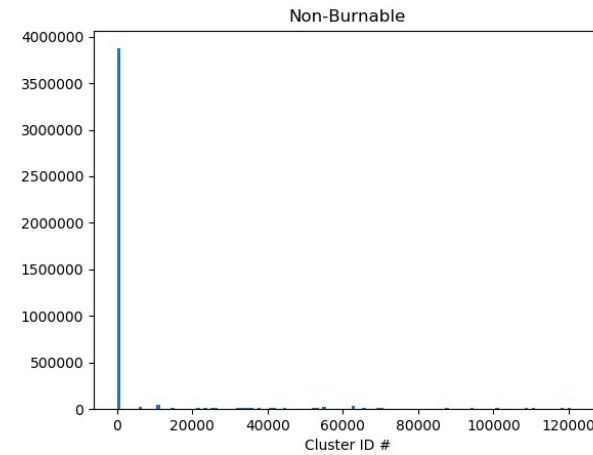
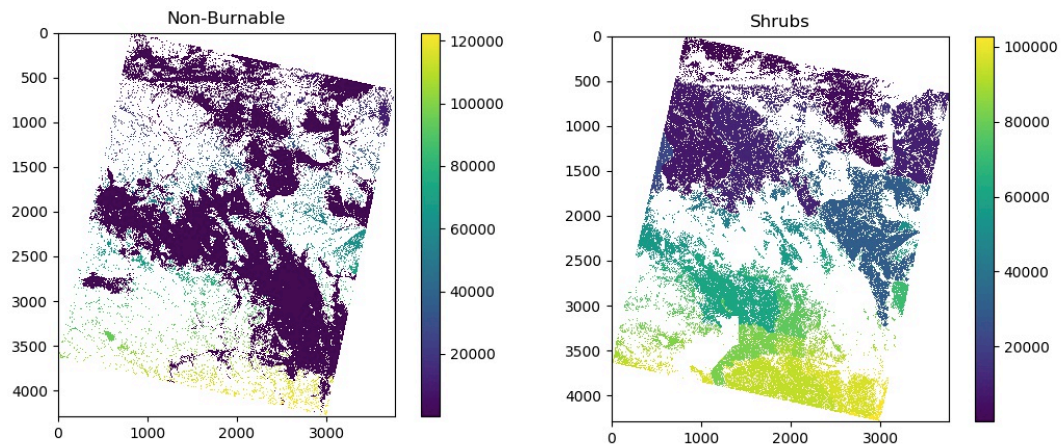
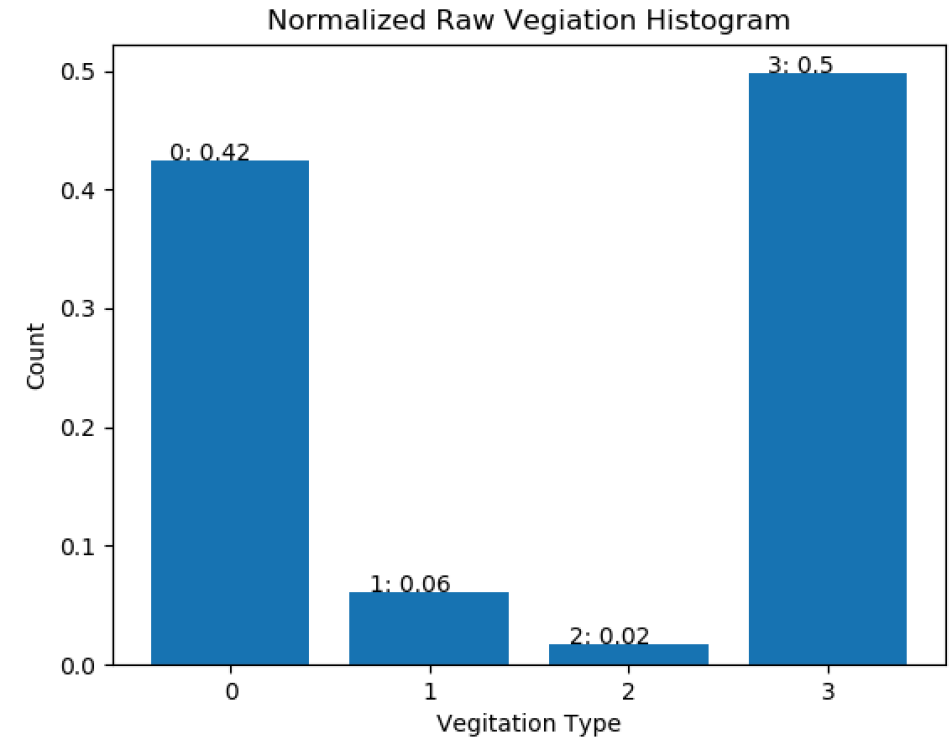
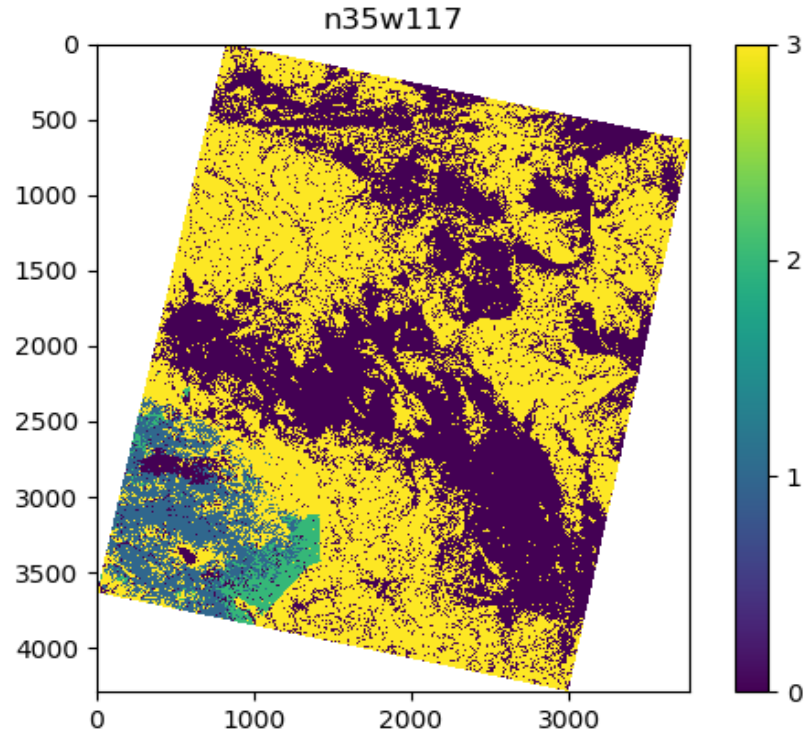
Current Work: Topography

Features: Ridge Detection

- Using "steepest ascent" method described by Koka (2011)



Current Work: Vegetation



Future Work

- Create joint probability + research sampling algorithms
- Start FIRETEC runs for simple cases